

## **SECTION 501 PORTLAND CEMENT CONCRETE PAVEMENT**

**501.01 DESCRIPTION.** This work is the construction of portland cement concrete pavement on a prepared sub-grade or base course.

### **501.02 MATERIALS.**

**501.02.1 Concrete.** Furnish concrete meeting Section 551 requirements for class "AP" or "DP" concrete.

- A. Cement.** Furnish Type II portland cement meeting AASHTO M 85 requirements and the applicable requirements of Subsection 551.02.1.
- B. Air-Entraining Admixtures.** Furnish Air-entraining admixtures meeting Subsection 551.02.2 requirements.
- C. Fine Aggregates.** Furnish fine aggregate meeting Subsection 701.01.1 requirements.
- D. Coarse Aggregates.** Furnish coarse aggregate meeting Subsection 701.01.2 requirements.
- E. Water.** Furnish water for concrete meeting Subsection 713.01 requirements.

**501.02.2 Reinforcing Steel.** Steel-wire fabric and steel bar mat sizes and dimensions are specified in the Contract.

Furnish steel-wire fabric reinforcement in flat sheets.

Furnish bar mats and bars of structural or intermediate grade, as specified in the Contract.

Furnish all reinforcing steel meeting Subsection 711.01 requirements.

**501.02.3 Dowel Bars and Sleeves.** Furnish Grade 40 plain round dowel bars meeting AASHTO M 31 requirements.

Bar dimensions and placement in the pavement are specified in the Contract.

Do not use bars having burrs or other deformation that restrict slipping in the concrete.

Before delivery to the project, coat one-half the length of each dowel bar with one coat of zinc or tar paint. Furnish sleeves for dowel bars meeting the Contract requirements.

**501.02.4 Tie Bars.** Furnish ASTM A 615, Grade 40 deformed steel bars. The length, size, and spacing of the bars are specified in the Contract.

**501.02.5 Expansion Joint Filler and Joint Sealing Material.** Furnish expansion joint filler and joint sealing material meeting Subsection 707.01 requirements.

**501.02.6 Curing Compound.** Furnish AASHTO M 148 Type 2, white-pigmented, membrane-forming curing compound.

**501.03 CONSTRUCTION REQUIREMENTS.****501.03.1 Equipment.**

- A. General.** Do not begin paving operations until all equipment and tools for the pavement construction are available at the site.

Assure the equipment is in good mechanical condition, adjustment, design, and capacity.

Adjust, repair, or replace equipment failing to produce the specified work.

Use handling, batching, mixing, and concrete transporting equipment meeting the applicable requirements of Section 551 and the following.

Use batch plants for projects having 300 cubic yards (229.5 m<sup>3</sup>) or more portland cement concrete pavement that proportion aggregates and cement by weight using automatic and interlocked proportioning devices.

Use non-agitating hauling equipment with smooth, mortar-tight metal bodies that completely discharge the concrete at a uniform rate without segregation. Provide covers when necessary to prevent the concrete from drying out or being exposed to weather-related moisture.

Use belly-dump trucks only with the Project Manager's written approval.

Remove and dispose of concrete remaining in haul units before reloading with fresh concrete.

- B. Stationary Side Forms.** Use metal side forms strong enough to resist displacement from concrete and mechanical equipment pressures.

Use flexible or curved forms for curves with 100 foot (30.5 m) radii or less.

Forms must:

1. Hold abutting sections in alignment;
2. Be adjustable for vertical and horizontal curvature;
3. Have a minimum depth equal to the specified concrete edge thickness;
4. Not have horizontal joints;
5. Have a base width greater than or equal to the depth;
6. Have at least 3 staking points for each 10 foot (3 m) of length that securely lock to the form stake;
7. Have flange braces and staking pockets that extend outward on the base at least two-thirds the height of the form.

Use wooden forms only with the Project Manager's written approval. Include in the request to use wooden forms complete details showing they meet the requirements for steel forms regarding strength, lines, grades, and depth.

Do not use forms in poor condition in the work. Repaired forms must be inspected and approved before use.

- C. Placing, Consolidating, and Finishing Equipment.** Place, consolidate, and finish concrete meeting the Contract requirements.

Operate only rubber-tired equipment on adjacent pavement. Pad crawler units to prevent pavement damage.

Keep the adjacent pavement and form tops clean to provide good contact with tires or crawler units.

1. **Slip-Form Pavers.** Use slip-form pavers having automatic controls for longitudinal and transverse grade from continuous wire control lines.

Maintain the control wire tension, support interval, and sensor operating pressure to prevent control wire deflection in excess of 3/16-inch (5 mm) below supports at mid-span. Immediately stop paving operations when deflection exceeds 3/16-inch (5 mm) and resume once corrected.

Use self-propelled slip-form pavers to place and finish the concrete that are capable of negotiating all grades without external tractive force.

Equip the slip-form paver with an auger or other approved strike-off device to distribute the concrete to a uniform depth ahead of the screed.

Use sliding forms that are laterally rigid to prevent spreading.

Use slip-form pavers that consolidate the plastic concrete by internally vibrating the full paving width and depth. Use transverse vibrating units that do not project outside the specified paving section thickness and are positioned ahead of the screed a minimum distance equal to the pavement thickness. A series of longitudinal vibrating units may be used as an alternate. Vibrators may be the immersed tube type or a series of equally spaced longitudinal vibrating units.

The maximum spacing of each unit in a series of longitudinal units is 24-inches (610 mm) measured center-to-center of the units.

Each vibratory unit must provide at least 7000 vibrations per minute with the amplitude visibly perceptible on the concrete surface within 1 foot (305 mm) of the entire length of the vibrating unit. Equip the Paver with a tachometer or other approved device for measuring the actual vibration frequency.

2. **Auxiliary Finishing Equipment.** Use finishing equipment behind the slip-form paver that automatically maintains alignment from an external reference.

Provide hand floats, edging tools, and other hand-finishing equipment to finish the surface as specified.

3. **Stationary Side Form Method.** Submit to the Project Manager details for all equipment proposed for spreading, strike-off, consolidating, screeding, and floating before use.

4. **Roadbed Planers.** Equip the roadbed planer with adjustable steel cutting edges mounted in a rigid frame to trim the roadbed to the specified elevation and crown under all operating conditions. The planer wheels must ride on the forms or adjacent pavement.

5. **Concrete Spreaders.** Use a self-propelled spreader that uniformly spreads the concrete between forms and has an adjustable blade or head for striking off the concrete to the required height and crown.

6. **Vibrators.** Use full-width concrete slab vibrators of the surface pan type or the internal type with immersed tube or multiple spuds.

The vibrators may be mounted on the spreader, the finishing machine, or on a separate carriage.

Do not allow the vibrators to come in contact with the joint load transfer devices, the sub-grade, or side forms.

Use surface vibrator's having a minimum frequency of at least 3,500 impulses per minute; tube vibrators with a minimum frequency of at least 5,000 impulses per minute; and spud vibrators with a minimum frequency of 7,000 impulses per minute.

Use hand-operated or machine-mounted spud-type internal vibrators next to forms having a minimum frequency of 3,500 impulses per minute.

7. **Bridge Deck Finishing Machines.** Use transverse-finishing rotating drum bridge deck finishing machines when stationary side forms are allowed.
8. **Mechanical Floats.** Use mechanical floats that produce a surface true to the required crown and smoothness, free from honeycomb or excessive mortar.

Assure the float makes accurate incremental adjustments to the required crown without interrupting the float operation.

The mechanical float may be self-propelled or attached to the rear of the transverse finishing machine.

**501.03.2 Pre-paving Conference.** Attend a pre-paving conference, conducted by the Department, to be held at least 24 hours before paving starts.

The conference topics will include equipment, construction methods, specification requirements, and lines of communication.

The conference must include the foreman, other contractor personnel that will supervise the concrete paving operations and key Department inspection personnel.

**501.03.3 Aggregate Sampling and Testing.** Furnish aggregates that meet the gradation requirements, fineness modulus, and deleterious material limits specified in Subsection 701.01. Provide all sampling and testing to meet these requirements during aggregate production.

**501.03.4 Aggregate Production.** Produce aggregate meeting the applicable requirements of Section 551.

Produce and stockpile at least one-third of the quantity of each size aggregate necessary to produce the plan quantity of portland cement concrete pavement before paving operations begin.

**501.03.5 Acceptance of Aggregate.**

- A. **Sampling and Testing.** The Project Manager will determine when samples are taken and will test the aggregate for acceptance.

Furnish and operate the aggregate sampling devices, witnessed by the Project Manager. Take samples at a point immediately before the aggregates are combined and enter the mixer, witnessed by the Project Manager. Samples may be split to a minimum 50 pounds (23 kg). Furnish the samples to the Project Manager immediately after sampling.

Acceptance samples will be randomly selected.

The approximate quantity represented by each sample is specified in MT-601.

Additional samples may be selected and tested.

- B. Lot Size.** The concrete quantity in each day's production will constitute a lot whenever production schedules and material continuity permit.

The Project Manager may establish a lot consisting of the quantity represented by any number of consecutive random samples from 3 to 7 inclusive if the Project Manager determines it is necessary due to production runs, significant material changes, or other unusual characteristics of the work.

- C. Acceptance.** Portland cement concrete pavement is evaluated for price adjustment on a lot-by-lot basis under Subsection 105.03.2, when deviation from specified aggregate gradation limits, fineness modulus limits for fine aggregate, or percent passing the number 200 sieve (0.075 mm) for coarse aggregate occurs on one or more tests for a lot.

Payment for a lot where a price reduction applies under the acceptance provisions in Subsection 105.03.2 is calculated using the following formula:

$$\text{Price Reduction} = \text{Contract Unit Price} \times 0.40 \times P/100 \times \text{Lot Quantity}$$

"P" is the percent reduction in contract price as defined in Subsection 105.03.2.

The Lot Quantity equals the plan quantity in cubic yards (cubic meters) or square yards (square meters) of the pavement section where the lot was placed.

**501.03.6 Mixing.** Mix concrete meeting Subsection 551.03.3 requirements.

**501.03.7 Transporting Concrete.** Transport concrete in equipment meeting Subsections 501.03.1 and 551.03.4 requirements.

**501.03.8 Placing and Finishing Concrete.** Place all portland cement concrete pavement for projects of 20,000 square yards (16,720 m<sup>2</sup>) or more, or bridge approach slabs, ramp tapers, and other small, restricted, or irregular areas, by the slip-form method.

Construct projects with 20,000 square yards (16,720 m<sup>2</sup>) or less pavement using the slip-form method or by stationary side-form method using bridge deck finishing equipment.

Submit the proposed procedures and equipment details for the side-form method for approval before paving.

Place the fresh concrete on the prepared roadbed as close as possible in front of the paving machine to minimize concrete handling. Do not routinely use front end loaders or other equipment at the paver for moving the fresh concrete once its placed on the roadbed.

Place concrete hauled in non-agitating equipment within 45 minutes from when the ingredients were charged into the mixer. Dispose of concrete that does not meet slump requirements at Contractor expense.

Place concrete hauled in agitator trucks within the time limits in Subsection 551.03.4(A).

Distribute the concrete to the specified slab thickness, with the finished surface at the specified grade, once the concrete is consolidated and finished.

Do not use vibrators to distribute concrete.

Place concrete only after the foundation course or sub-grade has been approved by the Project Manager.

Prepare the foundation course ahead of the paving operation equal to the anticipated daily production.

Place concrete around manholes or other structures once the structures are brought up to the required grade and alignment.

Dampen the base or sub-grade with a fine water mist immediately before placing concrete. Do not permit free-standing water to puddle on the surface.

If concrete placing is delayed or stopped in excess of one hour, construct an emergency transverse construction joint as directed.

Except for emergency transverse joints, do not construct a joint at any location other than as directed or specified.

Construct the pavement in full lane widths in a single operation.

Construct longitudinal joints between lanes or sections meeting Subsection 501.03.13(F) requirements.

Do not place concrete in longitudinal sections until the adjacent slab is 14 days old or has reached a minimum compressive strength of 2,000 pounds per square inch (13,800 kPa), determined by testing the standard cylinders cured under the same environmental conditions as the slab.

**A. Slip-Form Method.**

1. **General.** Place the concrete with a slip-form paver meeting Subsection 501.03.1© requirements that will spread, consolidate, screed, and float-finish the fresh placed concrete in one pass.

Operate the slip-form paver to maintain a continuous, forward movement. Assure all concrete mixing, delivering, and spreading provides uniform progress without stopping and starting the paver. If it is necessary to stop the paver, immediately stop the vibrators and tamping.

Maintain a uniform consistency in the concrete with a slump of 1 to 2-inches (25 to 50 mm).

The paver may be set to form a 3-inch (75 mm) or less battered edge while maintaining the top riding surface at the specified width.

Apply additional hand vibration at construction joints as required for consolidation.

2. **Straightedge Finishing.** After the concrete has been finished by mechanical finishing equipment, test for surface smoothness under Subsection 501.03.14 B.

Use a straightedge at least 10 feet (3 m) long and a handle 3 feet (.9 m) longer than one-half the pavement width for the test.

Test both parallel and at right angles to the centerline, and advance the straightedge along the pavement in maximum successive stages of one-half the straightedge length.

Correct sections not meeting tolerances and continue the straightedge testing and finishing until the surface meets the surface smoothness requirements.

The straight-edging requirements may be waived in writing by the Project Manager if it is demonstrated that the paving equipment will

consistently produce a surface meeting the surface smoothness tolerances.

Correct any pavement edge slump, excluding specified edging, exceeding 1/4-inch (6 mm) before the concrete has hardened.

If the edge slump on any 1 foot (305 mm) or longer length of hardened concrete exceeds 1-inch (25 mm), remove and replace the entire panel between the transverse and longitudinal joints.

Before the initial concrete set, round the pavement edges on each side of the transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints to the required radius. Construct a well-defined, smooth, dense mortar finish radius.

Hand finishing is permitted only for finishing sections with narrow irregular dimensions and to finish any concrete already deposited on the grade should a machinery breakdown occur.

Grind high spots exceeding 1/4-inch (6 mm) using approved methods. Fill low spots exceeding 1/4-inch (6 mm) with an approved epoxy-bonded grout as directed.

**B. Stationary Side Form Method.**

1. **Preparation of Sub-grade or Foundation Course.** Once the roadbed is finished and compacted under Section 203, trim, shape, and compact the sub-grade or foundation course meeting Section 301 to the specified lines, grades, and cross sections.

Extend the finished sub-grade 2 feet (610 mm) beyond each side of the planned pavement width.

Once the forms are set, re-shape and re-compact all disturbed sub-grade or foundation course using rollers or compactors working between the fine grading equipment and the paver.

Test the sub-grade or foundation course in advance of the paver for section and grade using an approved template. Mount the template on visible rollers with the tooth edge conforming to the required shape of the sub-grade when riding vertically on the forms. Remove excess material and fill low areas to the finish elevation with sub-grade or foundation material and compact to the specified density.

Maintain the finished sub-grade or foundation course in a smooth, compacted, undisturbed condition until the pavement is placed.

Moisten the sub-grade or foundation course as specified in Subsection 501.03.8 when placing the concrete.

2. **Form Setting.** Do not permit the forms to deviate more than 1/8-inch (3 mm) from the true plane of the form face or top. Do not permit the forms to warp, bend, or kink. Clean and oil forms before each use.

Cut the compacted foundation course or the sub-grade to grade providing firm contact for each form for its entire length at the specified grade. Fill low areas to grade in 1/2-inch (13 mm) lifts or less for 18-inches (460 mm) on each side of the base of the form and compact to the specified density. Settlement or springing of forms under the finishing machine is not allowed.

The forms will be checked for alignment and grade. Make any corrections before placing the concrete.

Correct unstable or disturbed forms or foundation courses and re-check the forms.

Prepare the foundation course and forms ahead of the paving operation equal to the average daily production.

Leave the forms in place at least 12 hours after the concrete has been placed unless earlier removal is necessary to permit sawing of transverse weakened plane joints. Exercise care in removing forms to avoid damage to the pavement edges.

3. **Strike-Off and Consolidation.** Strike off, screed, and consolidate the concrete with mechanical equipment to the specified crown and cross section providing a uniform surface texture. Avoid prolonged work over any area.

Maintain a uniform ridge of concrete ahead of the front screed of the finishing machine except when making construction joints.

4. **Floating.** Following strike-off and consolidation, finish the concrete surface with a mechanical float under Subsection 501.03.1 (C)(8).
5. **Straightedge Finishing.** Once the concrete is finished with the mechanical finishing equipment, test the surface smoothness and make corrections under Subsection 501.03.8(A)(2).

- C. **Final Surface Finish.** Produce the final surface finish by a light burlap drag longitudinally followed by transversely grooving the concrete to an approximate 1/8 to 3/16-inches (3 mm to 5 mm) deep.

Produce the grooves using mechanical equipment having square or circular spring steel tines 0.08-inch (2 mm) square or in diameter spaced on 3/4-inch (19 mm) centers.

Meet an average surface texture of from 0.035 (1 mm) to 0.060-inch (1.5 mm), as measured by MT-113 (sand patch test).

Use steel-tined hand rakes for the final surface finish for narrow, irregularly shaped ramp taper sections.

Use hand grooving methods that match that of mechanical equipment.

Produce the final surface finish of bridge approach slabs by either mechanical equipment or steel-tined hand rakes.

If the repair of high spots or low spots results in surface texture loss, re-groove the affected area to the specified texture at Contractor expense.

**501.03.9 Protection of Concrete From Rain.** Maintain materials at the project site to protect all un-hardened concrete surfaces from rain.

When rain appears imminent, stop paving operations and cover all surfaces of the un-hardened concrete with the protective covering.

**501.03.10 Evaluation and Repair of Rain-Damaged Concrete.** Follow The American Concrete Paving Association Technical Bulletin No. 17 for the evaluation of and acceptable repair methods for rain-damaged concrete.

All protective, remedial, and corrective work to produce acceptable pavement is at Contractor expense.



**501.03.11 Curing.**

- A. Membrane.** After the concrete is finished and the free water has left the surface, seal the entire surface area by machine spraying a uniform application of curing compound meeting Subsection 501.02.6 requirements. Apply the curing compound following the manufacturer's recommendation's before surface hair checking develops. Do not apply curing compound to the inside faces of joints to be sealed. If the groove coverage is not complete after the first application, apply a second coverage in the opposite direction from the first. Apply the second application within 30 minutes of the first application. Assure the equipment controls the curing compound application rate and uniformity. Use the coverage rate of 1 gallon per 150 square feet (0.27 L per m<sup>2</sup>) or follow the manufacturer's recommendations. Re-apply membrane curing compound to areas protected for less than 72 hours and that are damaged by sawing, rain, or other causes.
- B. Other Methods.** The Contractor may submit for approval, other curing methods.

**501.03.12 Handling and Placing Reinforcement.** Keep reinforcing steel clean, rust free, straight and distortion free, placed and held in position as specified.

Store reinforcing steel out of the weather, distributing only the steel needed for immediate placing along the work.

Assemble and place reinforcement for bar mats as specified. Maintain bar mat placement during concreting operations. Tie all intersections. Lap all adjacent ends at least 40 bar diameters.

**501.03.13 Joints.**

- A. Transverse Expansion Joints.** Construct transverse expansion joints as specified in the Contract.
- B. Expansion Joints at Structures.** Construct and seal joints between concrete approach slabs and structures or concrete pavement as specified.
- C. Transverse Construction Joints.** Make transverse construction joints as detailed in the Contract, at the end of each day's run, or where concrete work is interrupted for more than one hour. Form the joint using a clean plank cut to the plan cross section with an attached beveled strip to form a key-way. Remove the header and clean excess concrete on the sub-grade and joint face before placing fresh concrete against the joint.
- D. Transverse Contraction Joints.** Saw transverse contraction joints to the specified width, depth, and spacing using a power-driven gang saw with at least 4 separate blades. Saw initial or "control" transverse contraction joints at 54 foot (16.5 m) intervals or another multiple of the specified joint spacing that reduces uncontrolled cracking with the least number of initial contraction joints. Saw initial contraction joints as soon as possible after the concrete is placed. Do not permit the saw to tear or ravel the adjacent concrete. Saw the remaining contraction joints typically within 24 to 48 hours after concrete is placed.

Be responsible for determining joint-sawing methods, sequences, and timing to prevent random cracking. Immediately revise methods that cause random cracking. Repair or replace concrete defects resulting from errors in the work methods at Contractor expense.

Repair or replace broken slabs, random cracks, nonworking contraction joints near cracks, and spalls along joints and cracks under Subsection 501.03.15.

Protect saw cuts in concrete 60 hours old or less from rapid drying using twisted paper, fiber or rope cords, waterproof covering, or other approved methods.

Have at least one stand-by saw in good condition and additional saw blades at the job site during sawing operations.

Cut curbs and gutters to the required depth to prevent erratic cracking. Immediately after the joints are sawed, flush the groove with pressurized water and blow the groove out with compressed air to remove all dust, water, and slurry. Clean the groove using compressed air just before filling with joint filler.

Place hot-poured joint sealer in sawed joints to within 1/4 (6 mm) to 3/16-inch (5 mm) of the pavement surface when the pavement temperature is at least +40 °F (4 °C).

Do not use polyethylene strips to form transverse contraction joints.

- E. Longitudinal Joints.** Saw longitudinal joints to the specified width and depth within 3 days of placing the concrete.

Do not use plastic tape as a joint sealer.

Saw and apply hot-poured joint sealer meeting Subsection 501.03.13(D) requirements.

Assure the finished joint alignment is parallel to the centerline of the pavement and does not have irregularities exceeding 0.04 foot (12 mm), measured by a 12 foot (3.6 m) straightedge, except for normal centerline curvature.

- F. Key-way Longitudinal Joints.** Construct key-way joints as specified when adjacent pavement slabs are constructed separately.

**501.03.14 Surface Test.** Test the pavement surface using one of the following tests.

- A. Profilograph.** Furnish a 25 foot (7.6 m) wheel base California type profilograph and a competent operator to measure the surface smoothness before joint sealing. Do not exceed a maximum 3 mph (4.8 kph) operational speed. Calibrate, adjust, and operate the profilograph following the manufacturers instructions and California Test Method 526. Provide the Project Manager 24 hours advance notice before using the profilograph. The Project Manager will witness all profilograph recordings. The profilogram must record a scale of 1-inch (25 mm) to 25 feet (7.6 m) longitudinally and 1-inch (25 mm) to 1-inch (25 mm) vertically. Take a profile on a line parallel to and 3 feet (0.9 m) inside the outside edge of each traffic lane. Run the profilograph parallel to the pavement edge at all times. Additional profiles may be taken to define the limits of an out-of-tolerance surface. End the profiles 50 feet (15.2 m) from existing pavements, bridge

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ends, and intersections. The acceptable lane section profile is an average profile index of 12-inches (305 mm) per mile (1.6 km) or less with each lane section being 1/10 mile (161 m) long. The Project Manager will determine the profile index using California Test Method 526. Remove all high points in excess of 0.3-inch (8 mm) in 25 feet (7.6 m) or less within each 1/10 mile (161 m) section using a method approved by the Project Manager. Reprofile re-worked sections. All sections must have a maximum average profile index of 15-inches (380 mm) per mile to be accepted. Reprofile corrected areas to determine if the section has an average profile index of 15.

Contract unit price adjustments are made using the following schedule. The Contractor may elect to perform corrective work to reduce the average profile index when it is less than the corrective index but greater than the incentive index. Incentive will not be paid on sections with an initial index exceeding 15.

<b>Lane Average Profile Index (Inches per mile-per 1/10 Mile)</b>	<b>Contract Unit Price Adjustment</b>
Less than 6	\$0.50 per yd <sup>2</sup> incentive pay
6 to 10	Contract Bid Price
10 to 15	\$1.00 per yd <sup>2</sup> deduction
Over 15	Corrective work required

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<b>Lane Average profile Index (mm per 1.6 km-per 161 m)</b>	<b>Contract Unit Price Adjustment</b>
Less than 150 mm	\$0.60 per 1 m <sup>2</sup> incentive pay
150 mm to 255 mm	Contract Bid Price
255 mm to 380 mm	\$1.20 per 1 m <sup>2</sup> deduction
Over 380 mm	Corrective work required

The price adjustment will apply to the entire area of concrete for the 1/10 mile (161 m) lane segment. The area will be computed using plan width for the 1/10 mile (161 m) lane segments. Sections of pavement less than 1/10 mile (161 m) will be added to subsequent paving to provide a 1/10 mile (161 m) section.

No payment is made for any section with an average profile index exceeding 15 until it is re-worked and re-profiled to an average profile index of 15 or less. Re-work all areas not profilographed (50 feet (15.2 m) from bridge ends and intersections) with high points exceeding 0.3-inch (8 mm) in 25 feet (7.6 m) to 0.3-inch (8 mm) or less per 25 feet (7.6 m).

Complete all corrective work before measuring the pavement thickness.

Include all profilographing costs in the unit bid price for Portland Cement Concrete Pavement.

- B. Straightedge.** Use straightedge tests for sections of pavement less than 300 feet (91.5 m) in length. Once the concrete has hardened, test the pavement surface with a 10 foot (3 m) straightedge placed parallel to the pavement centerline.

Span each low spot and touch each high spot with the testing edge revealing all irregularities.

Correct all pavement showing a variation from the testing edge exceeding 1/16-inch (2 mm) per foot (305 mm) from the nearest contact

point with the testing edge or showing a total variation exceeding 1/4-inch (6 mm) from the 10 foot (3 m) straightedge by grinding until the areas are within the above limits.

Where the grinding methods would result in an unsatisfactory surface or in a slab thickness less than specified, the affected pavement may require an adjustment in unit price or removal and replacement under Subsection 501.03.20.

Perform all pavement corrections including removing and replacing of pavement at Contractor expense.

**501.03.15 Correcting Spall and Cracks.** Remove and replace pavement slabs cracked through the full depth into three or more parts.

Repair pavement slabs containing a single diagonal crack intersecting the transverse and longitudinal joints within 1/3 of the width and length of the slab from the corner by removing and replacing the smaller portion of the slab. Repair broken slabs as directed.

Groove and seal random cracks that penetrate the full depth of the pavement. Groove the top of the crack to 3/4-inch (19 mm) minimum depth and a width between 3/8-inch (10 mm) to 5/8-inch (16 mm) using an approved grooving machine. Use a vertical rotary-cutting machine that can follow the crack path and widen the top of the crack to the required section without spalling or damaging the concrete. Remove all loose and fractured concrete, and thoroughly clean and seal the groove with the sealant specified in the Contract.

The Project Manager will determine what random cracks are tight, don't penetrate the full depth of the pavement and will be left undisturbed. When requested by the Project Manager, determine the crack depth penetration by drilling and inspecting cores at Contractor expense.

When a transverse random crack terminates in or crosses a transverse contraction joint, fill the un-cracked portion of the joint with epoxy-resin mortar or grout, and route and seal the crack.

When a transverse random crack nearly parallels the planned contraction joint and is within 5 feet (1.5 m) from a contraction joint, route, seal, and fill the crack with epoxy-resin grout or mortar.

When a transverse random crack is more than 5 feet (1.5 m) from the nearest contraction joint in the pavement, seal both the joint and the crack. Thoroughly clean the joints before filling with epoxy-resin mortar or grout.

Repair spalls by making a saw cut at least 1-inch (25 mm) outside the spalled area and to a minimum depth of 2-inches (50 mm). When the spalled area abuts a joint, make a saw cut 2-inches (50 mm) deep or 1/6 the slab thickness, whichever is greater. Chip out the concrete between the saw cut and the joint or primary crack to solid concrete. Thoroughly clean the resulting cavity of all loose material. Apply

a prime coat of epoxy-resin binder to the dry, cleaned surface of all cavity sides, except the working joint faces to be retained. Apply the prime coat by scrubbing it into the surface with a stiff bristle brush. Place portland cement concrete or epoxy-resin concrete or mortar immediately following the prime coat application.

For spalled areas abutting working joints or working cracks penetrating full depth, place an insert or other bond breaker to maintain the joint or crack during the patch repair.

**501.03.16 Opening To Traffic.** Opening the pavement to traffic and the Contractor's vehicles is permitted when the longitudinal joints are complete and the compressive strength of 6 x 12-inch (155 by 305 mm) cylinders tested under AASHTO T 22 is at least 3,000 pounds per square inch (20,700 kPa) and the flexural strength of concrete beams (dimensions described in MT-101 of the Materials Manual) tested under AASHTO T 97 (ASTM C 78) is at least 500 pounds per square inch (3,450 kPa).

Place a temporary earth shoulder, or the permanent shoulder against the outside pavement edges before traffic is allowed on the pavement.

Opening to all traffic does not constitute a final acceptance of pavement.

**501.03.17 Integral Curb.** Construct the curb mono-lithically with the pavement.

Construct the inside face of the curb true to the lines and grades in the Contract using the finish specified for the concrete pavement, including longitudinal floating and burlap drag finishing.

Test the surface for longitudinal trueness with a straightedge while the concrete is still plastic. Meet the same surface requirements specified for the concrete pavement.

Continue concrete pavement joints through the integral curb at the same locations, of the same type, and constructed in the same manner.

Cure the integral curb as specified for concrete pavement.

**501.03.18 Weather and Night Limitations.** Place concrete at night only with the Project Manager's written approval.

Stop concrete work when the ambient temperature falls below 40 °F (4 °C) and do not resume until the ambient air temperature reaches 35 °F (2 °C) and is rising.

Do not place concrete on a frozen foundation course or sub-grade.

Remove and replace all concrete damaged by frost at Contractor expense.

**501.03.19 Protection of Concrete.** Cover the concrete with an approved commercial insulating blanket covering all pavement if the ambient temperature falls below 35 °F (2 °C) during the cure period. Leave in place for 7 days.

The Project Manager may direct the leaving the blanketing in place beyond the 7 day curing period.

**501.03.20 Pavement Thickness.** Construct concrete pavement to the specified thickness. Tolerances allowed for sub-grade construction and specifications that may affect thickness do not modify the thickness requirements.

A primary unit of pavement is the pavement area placed in each day's paving operations. Within a primary unit of pavement, there may be an area or areas that are determined to be a secondary unit or units of pavement, as specified in Subsection 501.03.20(B), Thickness Deficiency not exceeding 0.07 foot (21 mm). The primary unit area will be reduced by the secondary unit area.

Thickness measurements are made in each primary unit of pavement with a minimum one measurement for each 1,000 linear feet (305 m) of traffic lane, or fraction thereof, of pavement placed. The number of thickness measurements within each primary unit, both longitudinally and transversely, are determined by the Project Manager.

Thickness measurement locations are determined by random sampling under MT-416. Thickness measurements will be made using MT-106 to the nearest 0.01 foot (3 mm).

Pavement thickness variation is determined by comparing the actual thickness measured with the specified thickness. The variation is determined to the nearest 0.01 (3 mm) foot as either excess or deficient variation.

Secondary thickness measurements will be made under Subsection 501.03.20(B).

When portland cement concrete pavement is placed using wire-line control over a base course constructed under a previous contract, pavement thickness variation measurements are made from a taut string line placed transversely across the pavement between grade points for the wire-line controls. Measurements are made from the string line to the pavement surface at 3 points across the section. Deviations from the planned cross section are computed for each point. The deviations for the 3 points are averaged and represent the thickness variation for that section. Three random sections are measured for each 1,000 linear feet (305 m) of traffic lane, or fraction thereof, and are averaged to represent that portion of a primary unit.

These measurements are the thickness deviations for applying the requirements of Subsections 501.03.20(A) and (B).

Fill all remaining holes in the concrete pavement after the thickness measurements are made with concrete of the same quality as that used to construct the pavement, at Contractor expense.

**A. Thickness Deficiency Not Exceeding 0.07 Foot (21 mm).** If all of the deficient thickness variations in a primary unit do not exceed 0.07 foot (21 mm), the thickness variations in the unit will be averaged algebraically to determine the average thickness deficiency. For determining the average thickness deficiency, an excess thickness variation of more than 0.03 foot (9 mm) greater than the thickness specified is considered to be 0.03 foot (9 mm) greater than the specified thickness.

For each primary unit of pavement that is deficient in average thickness, pay to the Department, or the Department will deduct from any monies due or that may become due the Contractor under the Contract, a sum computed by applying the deficiency adjustment from Table 501-1 to the quantity of the unit.

**TABLE 501-1  
CONCRETE PAVEMENT THICKNESS DEFICIENCY**

Average Thickness Deficiency		Proportional Part of Contract Price
Ft.	(mm)	Allowed
0.02	6	100%
0.03	9	80%
0.04	12	68%
0.06	18	57%
0.07	21	50%

For average thickness deficiencies of less than 0.02 foot (6 mm), no deficiency adjustment is made.

Average thickness deficiencies greater than 0.02 foot (6 mm) are rounded to the nearest 0.01 foot (3 mm) and the deficiency adjustment made using Table 501-1.

- B. Thickness Deficiency Exceeding 0.07 Foot (21 mm).** For each deficiency variation in a primary unit exceeding 0.07 foot (21 mm), the Project Manager will determine from secondary thickness measurements the dimensions of the secondary unit area where the apparent thickness deficiency exceeds 0.07 foot (21 mm).

The determination of the limits of the secondary unit area are made by making one randomly located secondary thickness measurement in each pavement panel adjacent to the panel in which the original measurement in the primary unit was made. This method will continue until the secondary unit area is bounded by panels in which the secondary measurement is deficient in thickness by 0.07 foot (21 mm) or less.

The secondary unit area is made up of entire panels only. Panels are the areas bounded by longitudinal and transverse joints and pavement edges.

If a transverse weakened plane joint has been omitted at the location where a volunteer crack exists, the volunteer crack is considered a transverse joint only if the adjacent pavement is not to be removed and replaced.

The Project Manager will determine within the limits of the secondary unit area, which panels will require replacement and which panels may remain in place using procedures (1) and (2) below:

1. At Contractor expense, remove and replace the deficient concrete pavement panels with new concrete meeting all Contract requirements. If the area to be removed is not bounded by longitudinal or transverse joints, saw the weakened plane joints at Contractor expense at the

locations designated by the Project Manager. Lower the sub-grade or base to meet the full thickness requirements. Replaced pavement will be tested for thickness requirements using additional secondary measurements and is subject to all of the Contract requirements.

2. The Contractor may leave deficient pavement panels in place if the panels meet all of the other Contract requirements and pay to the State 50% of the contract unit price per square yard (square meter) or cubic yard (cubic meter) for those pavement panels left in place, or the Department may deduct that amount from any monies due or that may become due the Contractor under the Contract. The decision to leave a deficient panel in place will be by contract modification under Subsection 105.03.

The cost of all secondary thickness measurements made under this Subsection will be deducted from any monies due or that may become due the Contractor under the Contract.

After eliminating the secondary unit area or areas and thickness measurements from consideration, the average thickness deficiency of the remainder of primary unit areas will be determined under Subsection 501.03.20(A). Secondary thickness measurements made outside of a secondary unit area will be used to determine average thickness variation in the remaining primary unit area in which the measurements are taken.

The Contractor is not entitled to any additional compensation or time extension due to these requirements.

If the Contractor believes that the number of thickness measurements made in primary unit areas by the Project Manager are insufficient to indicate the actual pavement thickness placed, the Contractor may request the Project Manager to take additional thickness measurements. The additional calculated variations will be averaged with the original variations to determine the average thickness variation.

The Project Manager will randomly select the location of all additional thickness measurements.

The cost of all additional measurements made will be deducted from any monies due or that may become due the Contractor under the Contract.

#### **501.04 METHOD OF MEASUREMENT.**

**501.04.1 Square Yard Measurement.** Portland cement concrete pavement is measured by the square yard (square meter) to the nearest 1/10 square yard (0.1 m<sup>2</sup>).

The measured width is from outside to outside of completed pavement, not exceeding the specified width or the width ordered by the Project Manager.

The length is measured along the centerline of the pavement surface.

Fillets for widened sections or at drainage structures and similar locations placed monolithic with the pavement are measured as pavement.

Areas constructed other than as pavement are deducted from the pavement area. No deduction is made for any fixture located within the pavement limits that has a surface area in the plane of the pavement surface of 1 square yard (0.80 m<sup>2</sup>) or less.

Integral curb is not measured for payment.



**PORTLAND CEMENT  
CONCRETE PAVEMENT**

**501.05**

**501.04.2 Cubic Yard Measurement.** Portland cement concrete pavement is measured in cubic yards (cubic meters).

The concrete in cubic feet (cubic meters) per batch is calculated by determining the weight per cubic foot (cubic meter) of a batch using Montana Test Method MT-509 and dividing the result into the total accumulated weight of cement, aggregates, and water used in that batch.

The volume of concrete per batch is determined at least twice daily.

The volume per batch for each day's paving run is determined by averaging all volume determinations made that day.

The volume of concrete for payment for each day's run is the total number of batches accepted and placed multiplied by the volume per batch as outlined above.

**501.05 BASIS OF PAYMENT.** Payment for the completed and accepted quantities is made under the following:

<b><u>Pay Item</u></b>	<b><u>Pay Unit</u></b>
Cement Concrete Pavement	Square Yard (square meter) or Cubic Yard (cubic meter)

Payment at the contract unit price is full compensation for resources necessary to complete the item of work under the Contract.